National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Atmospheric Infrared Sounder

Middle Tropospheric CO_2 and O_3 by the Atmospheric Infrared Sounder

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Atmospheric Infrared Sounder

Overview

- **Motivation**
- **Validation of AIRS CO_2**
- **Large-scale dynamics at the polar region**
- **Semi-Annual Oscillation in CO_2**

Motivation

- Polar regions have profound significance for climate, however, there are a lot of unknown due to limited observations.
- Current models cannot work well in the polar region.
- One important issue is to simulate the exchange between stratosphere and troposphere correctly.

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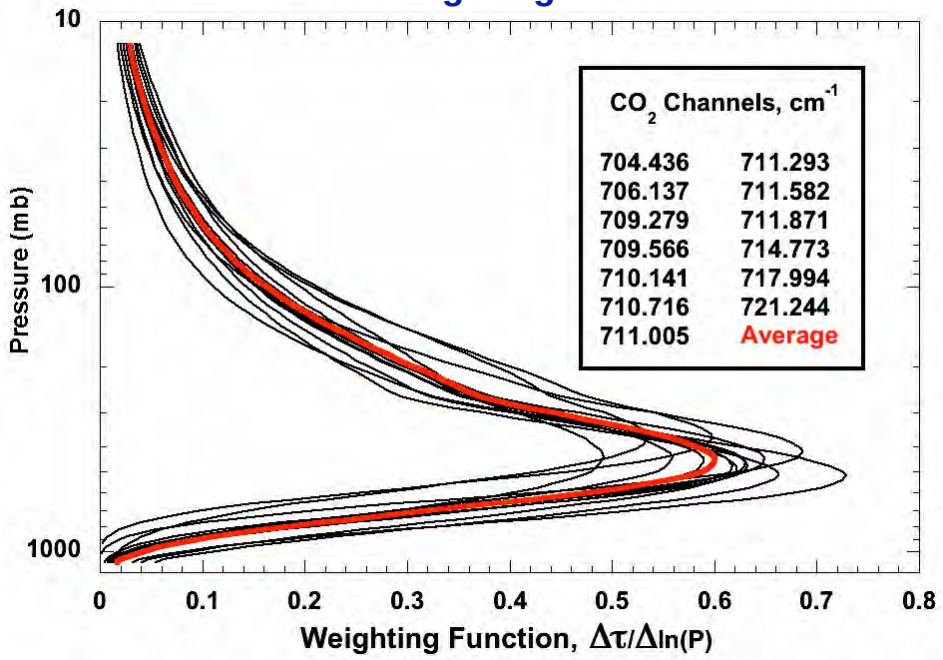
Atmospheric Infrared Sounder

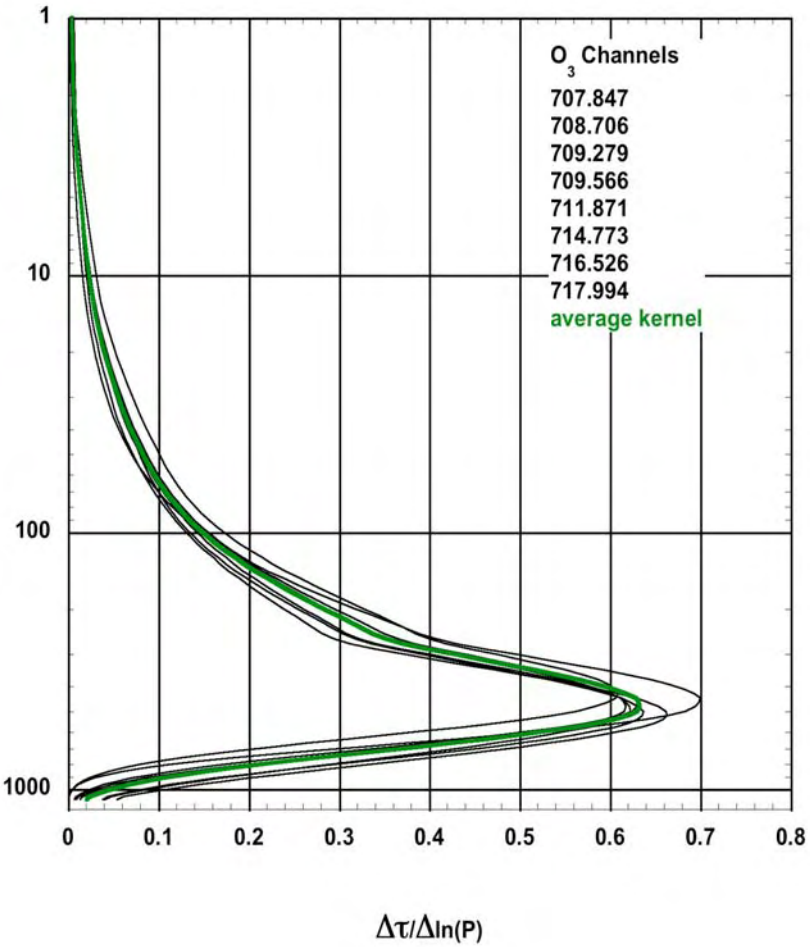
Data

- AIRS CO_2 and O_3

CO2 Weighting Function



O3 Weighting Function

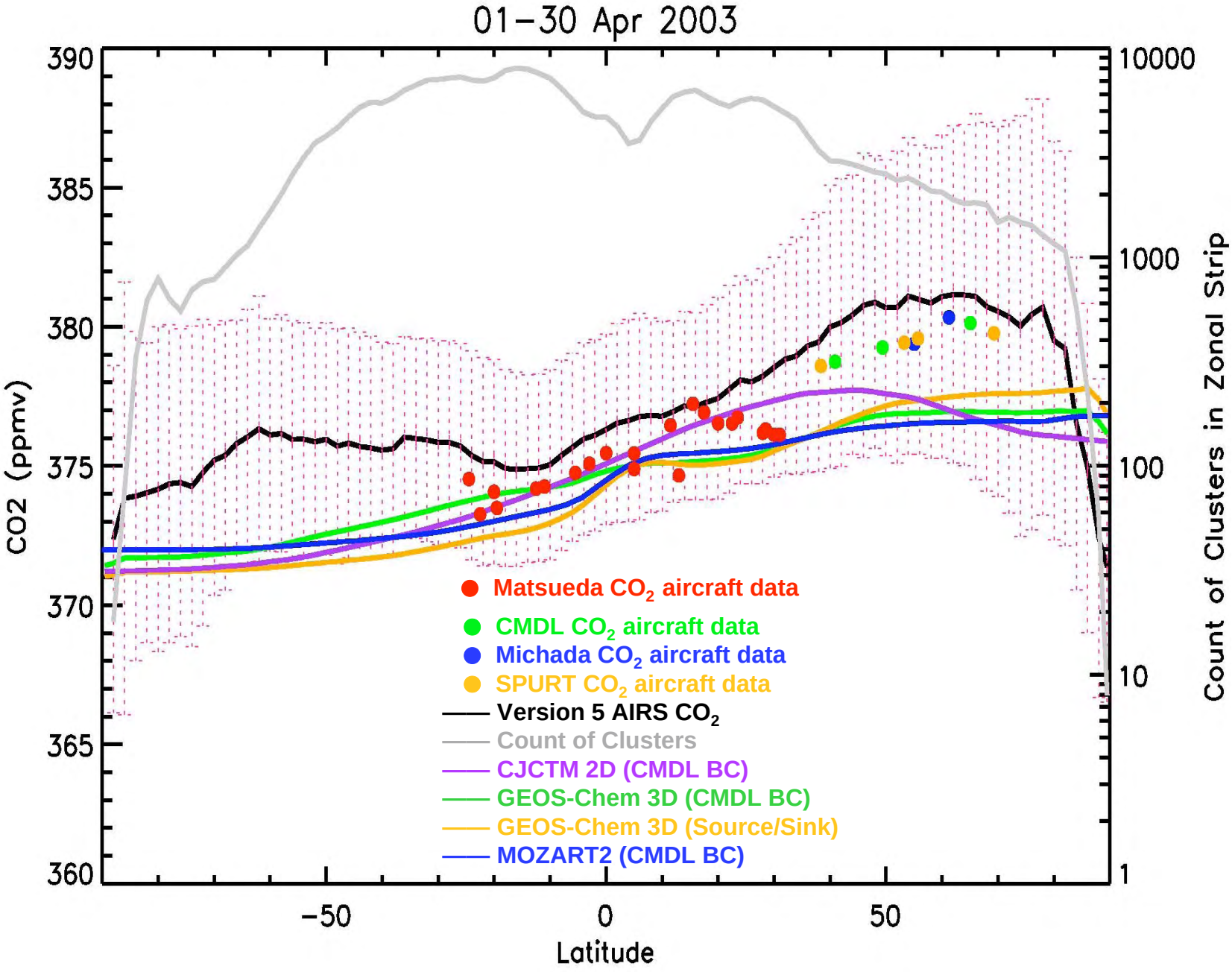


CO_2 maximum sensitivity is at 500-300 hPa.
O_3 maximum sensitivity is at 300 hPa.

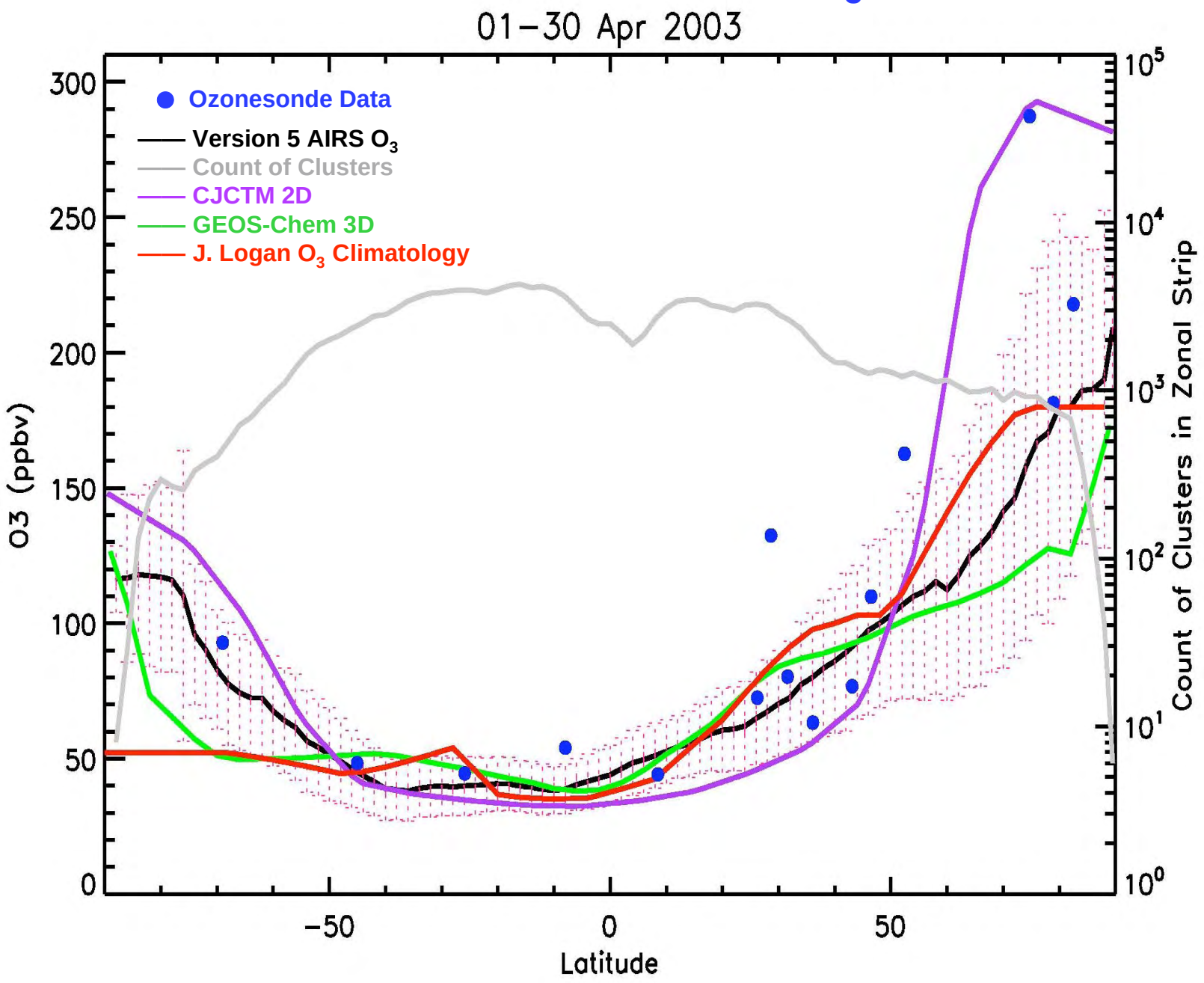
Data

- AIRS CO_2 and O_3
- Aircraft Data of CO_2 from *Matsueda et al*. [2002], Climate Monitoring & Diagnostics Laboratory (CMDL), and SPURT Aircraft [*Hoor et al*., 2004]
- Ozonesonde data from World Ozone and Ultraviolet Data (WOUDC)

Version 5 VPD AIRS CO_2



Version 5 VPD AIRS O_3



Stratospheric Sudden Warming (SSW)

- Strongest dynamical coupling between stratosphere and troposphere

- During SSW:

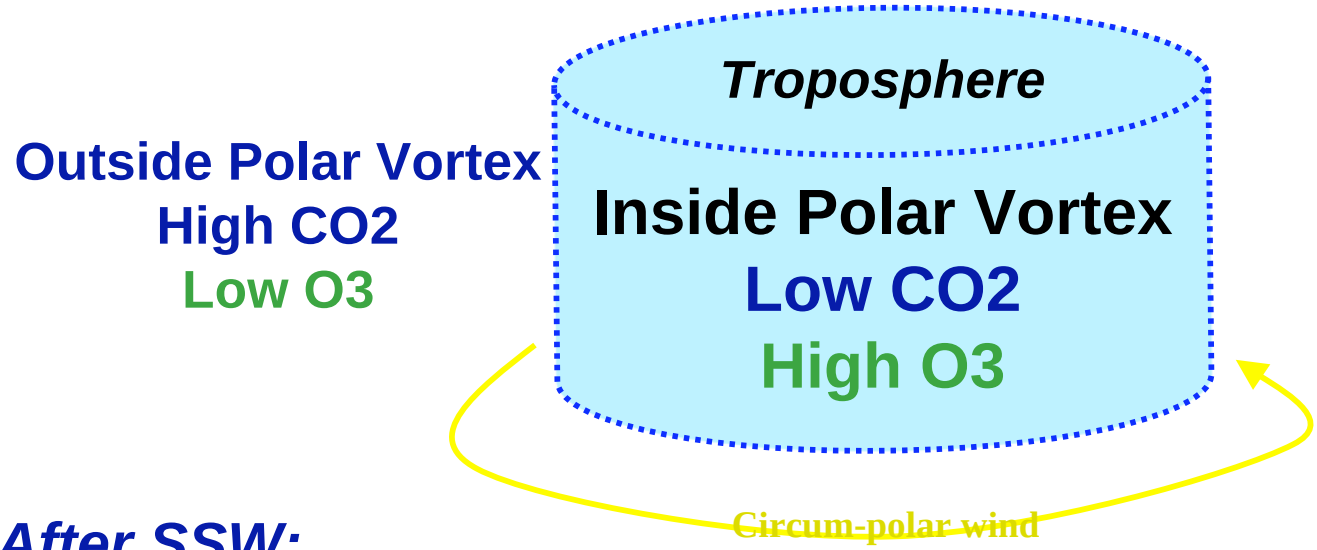
  Polar stratospheric temperature rise and the circum-polar flow reverse direction in a few days

- After SSW:

  Decrease of vortex area; Less downwelling in the polar region

- Important influence on chemical tracers

Influence of Sudden Warming on Tracers



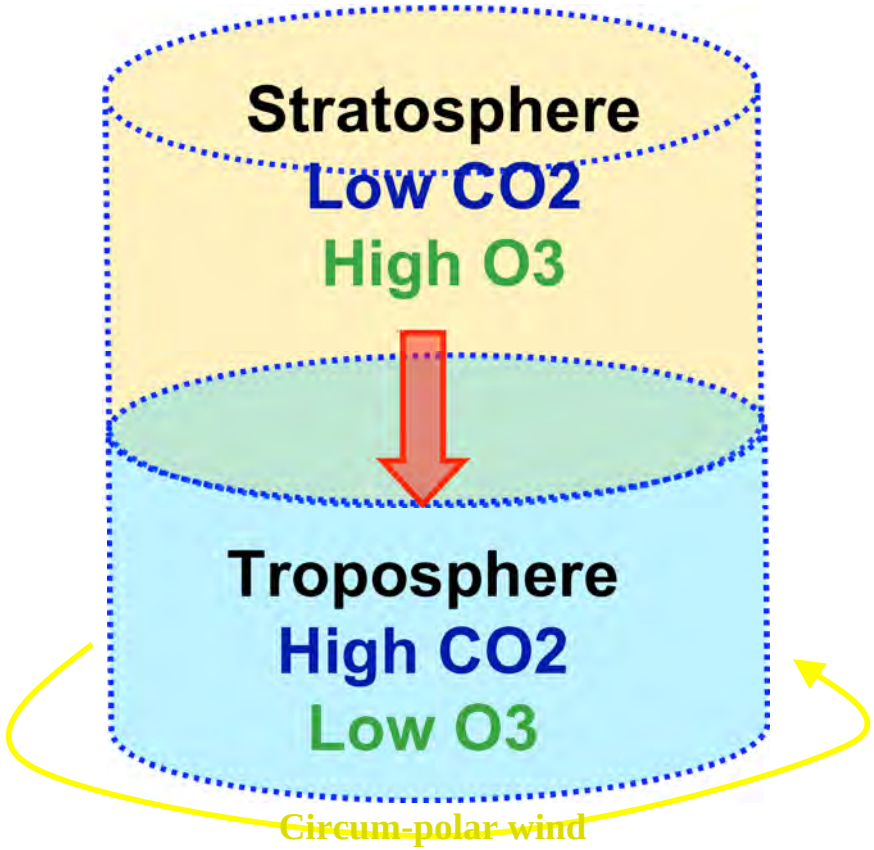
After SSW:

Decrease of Vortex Area -----> High CO_2 is transported into Pole

Low O_3 is transported into Pole

Polar CO_2 should increase and polar O_3 should decrease after the final warming

Influence of Sudden Warming on Tracers

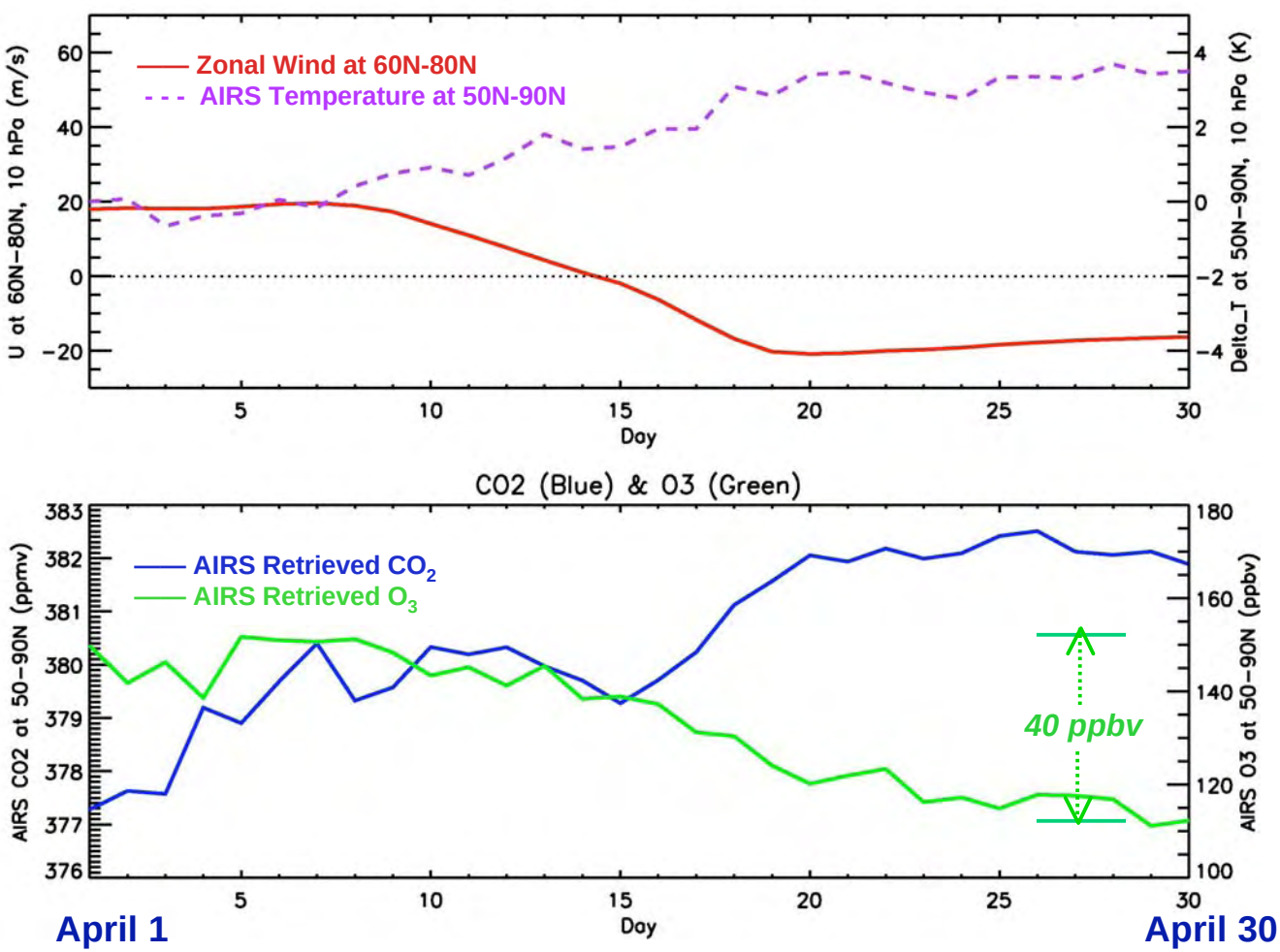


After SSW:

Less Downwelling -----> Less stratospheric low CO_2 (high O_3) will be transported into troposphere

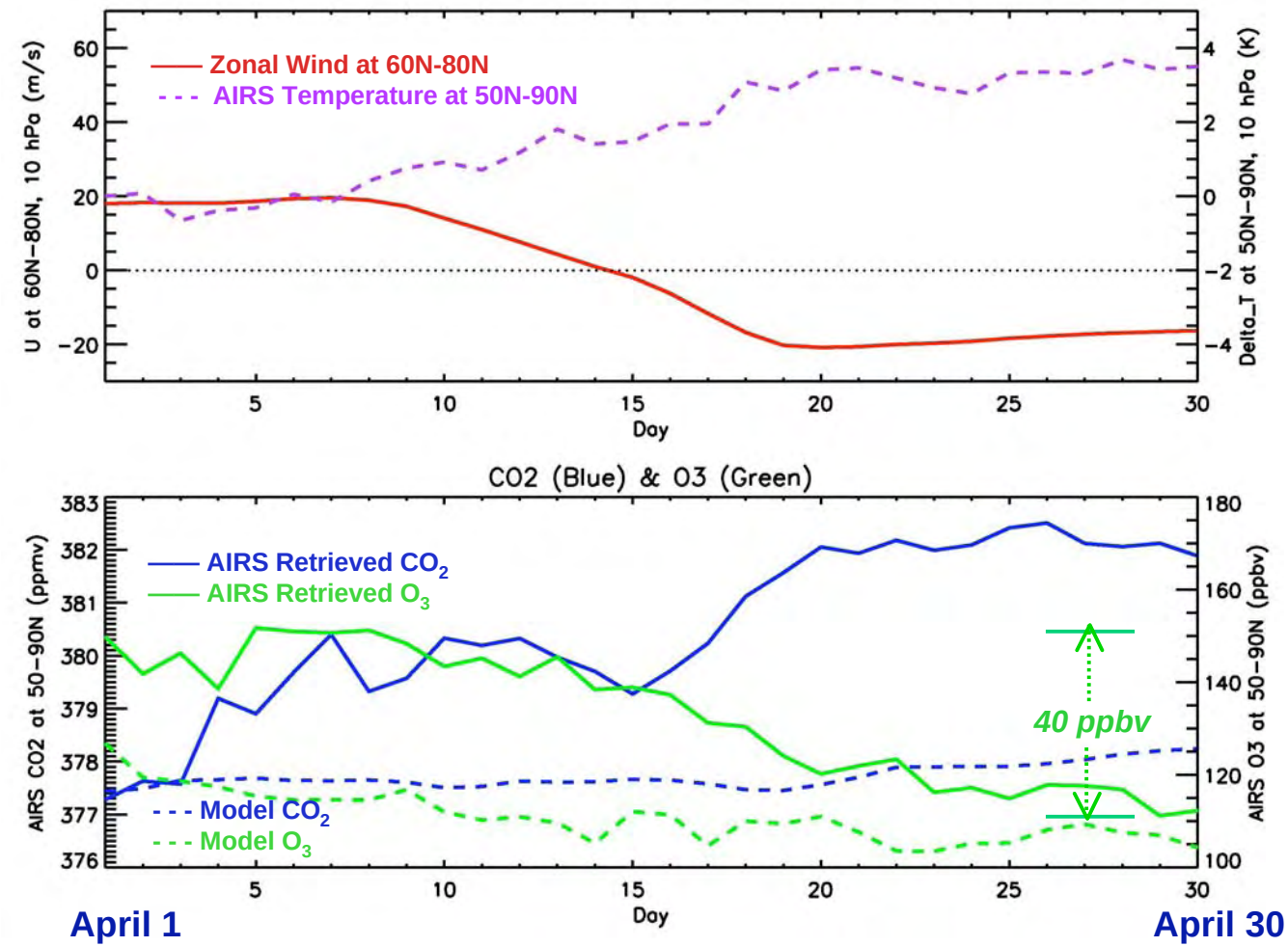
Mid trop CO_2 should increase and mid trop O_3 should decrease after the final warming

Influence of Sudden Stratospheric Warming on CO_2 and O3
AIRS- April 2003



AIRS retrieved upper tropospheric CO_2 increases while AIRS 300 mb O_3 decreases following a sudden stratospheric warming event

Influence of Sudden Stratospheric Warming on CO_2 and O3
AIRS- April 2003



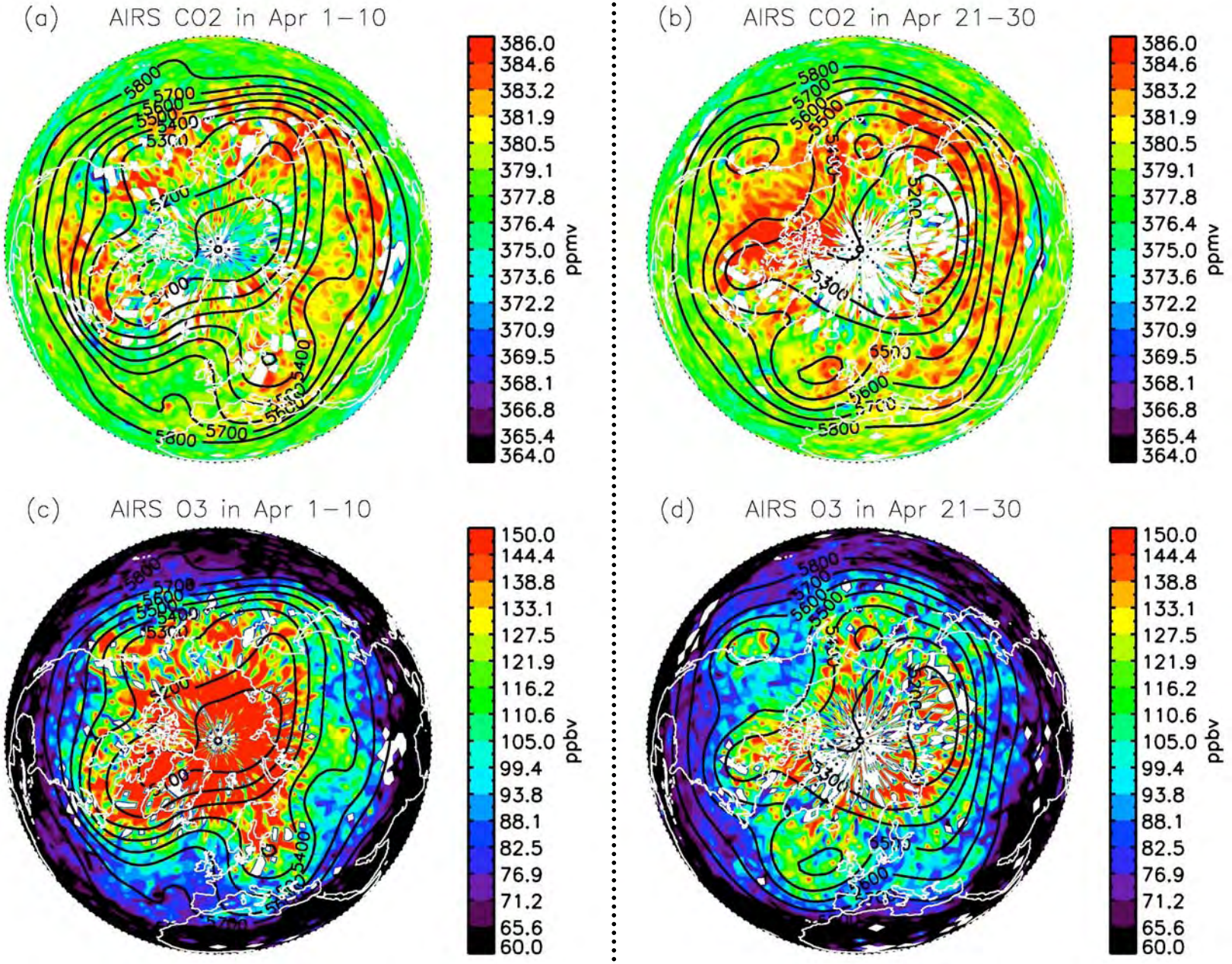
AIRS retrieved upper tropospheric CO_2 increases while AIRS 300 mb O_3 decreases following a sudden stratospheric warming event

Before SSW

After SSW

CO2

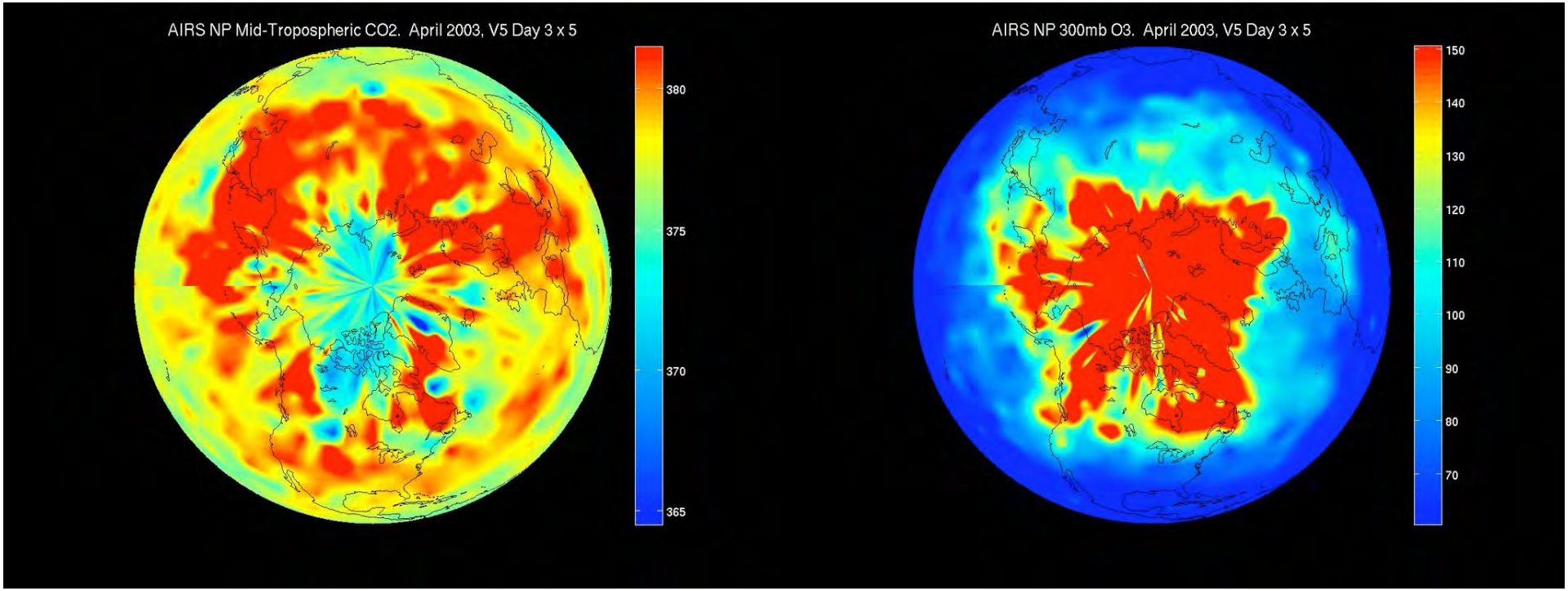
O3



Contour: NCEP2 GPH at 500 hPa

AIRS CO_2 (Apr 2003)

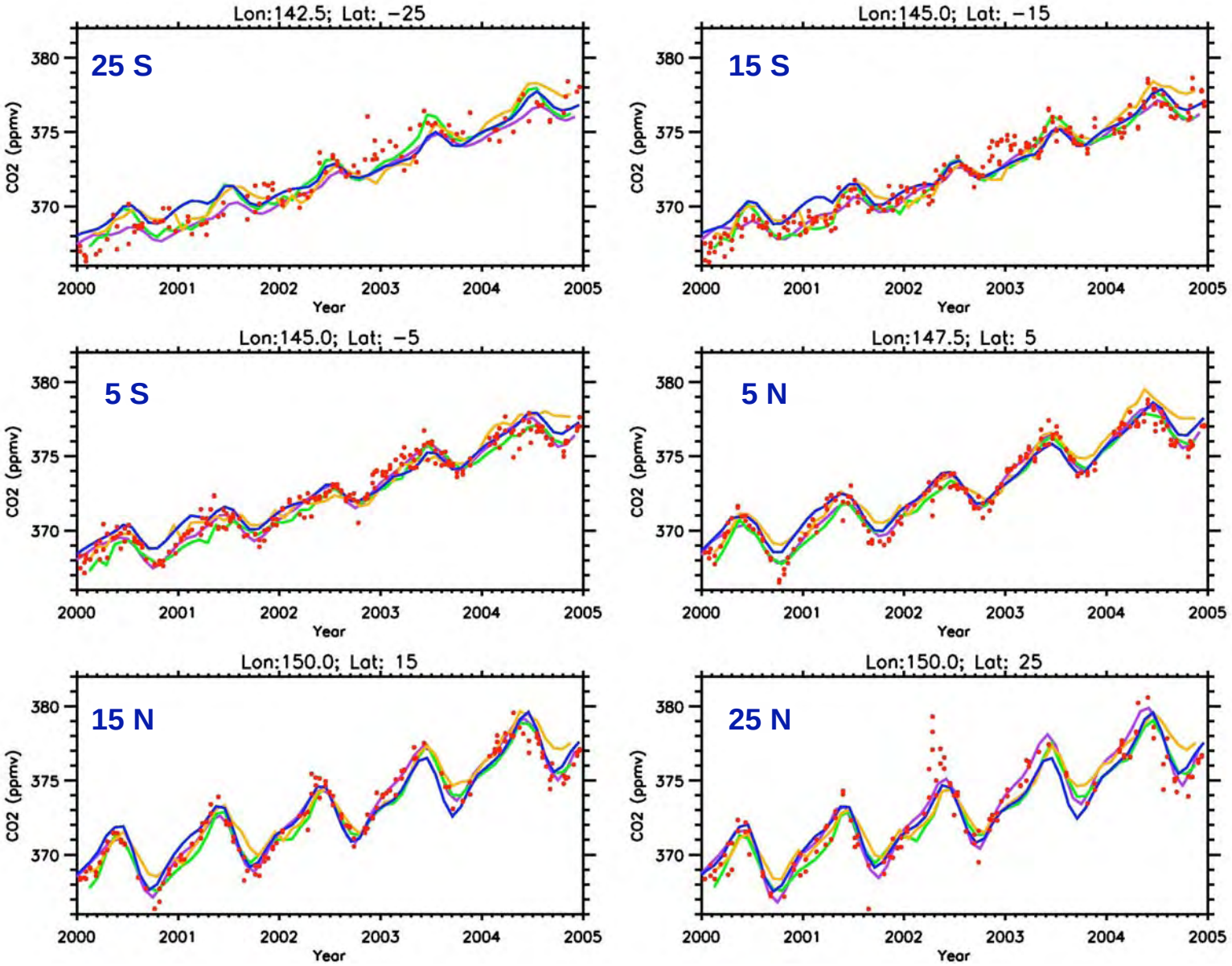
AIRS O_3 (Apr 2003)



Overview

- Motivation
- Validation of AIRS CO_2
- Stratospheric Sudden Warming: Influence on CO_2 and O_3
- **Semi-Annual Oscillation in CO_2**

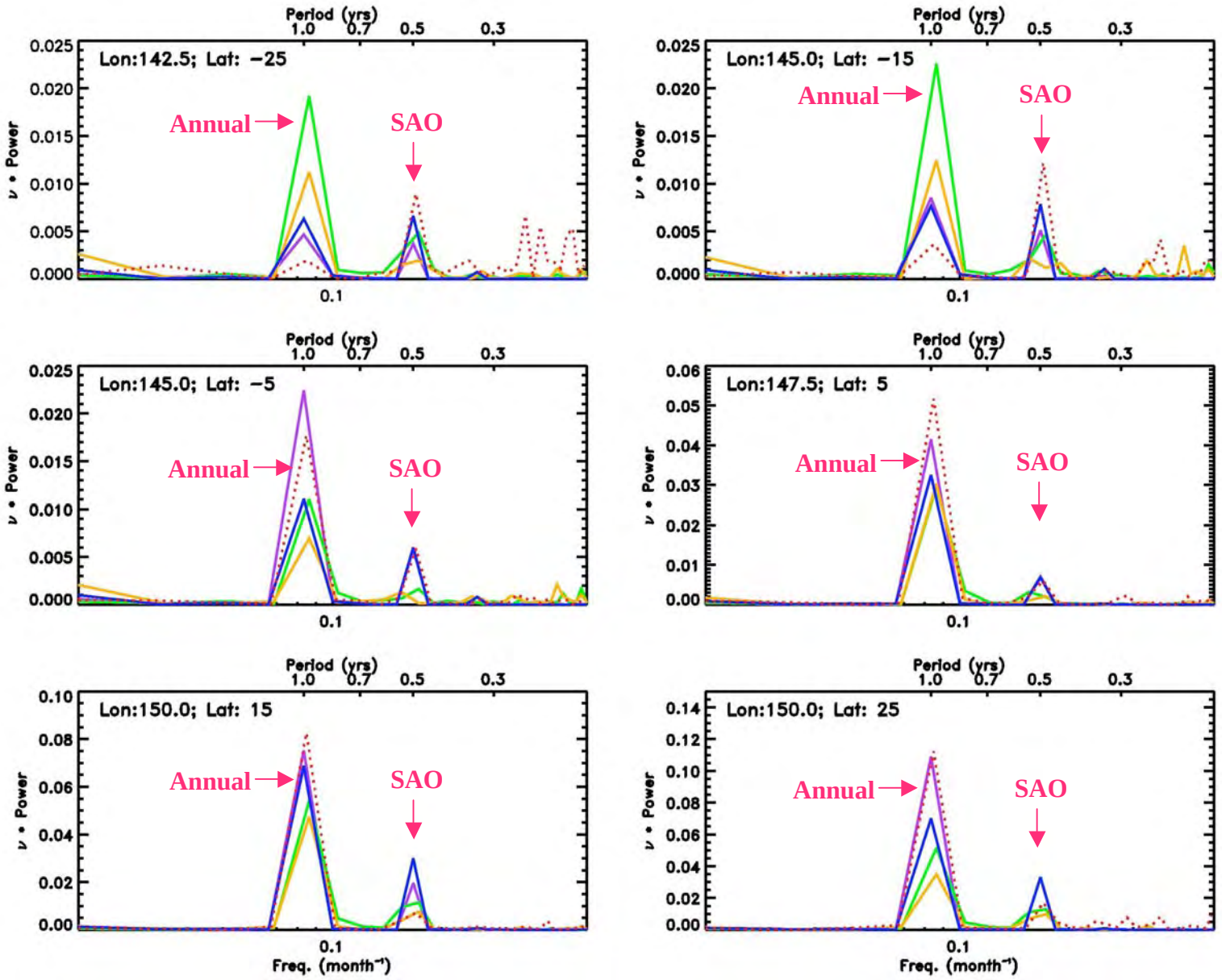
Semi-Annual Oscillation in Aircraft and Model CO_2



● Matsueda CO_2 aircraft data —— GEOS-Chem 3D; G-4 (CMDL BC) —— GEOS-Chem 3D; G-4 (Source/Sink)

—— CJCTM 2D (CMDL BC) —— MOZART2 (CMDL BC)

Semi-Annual Oscillation in Aircraft and Model CO_2



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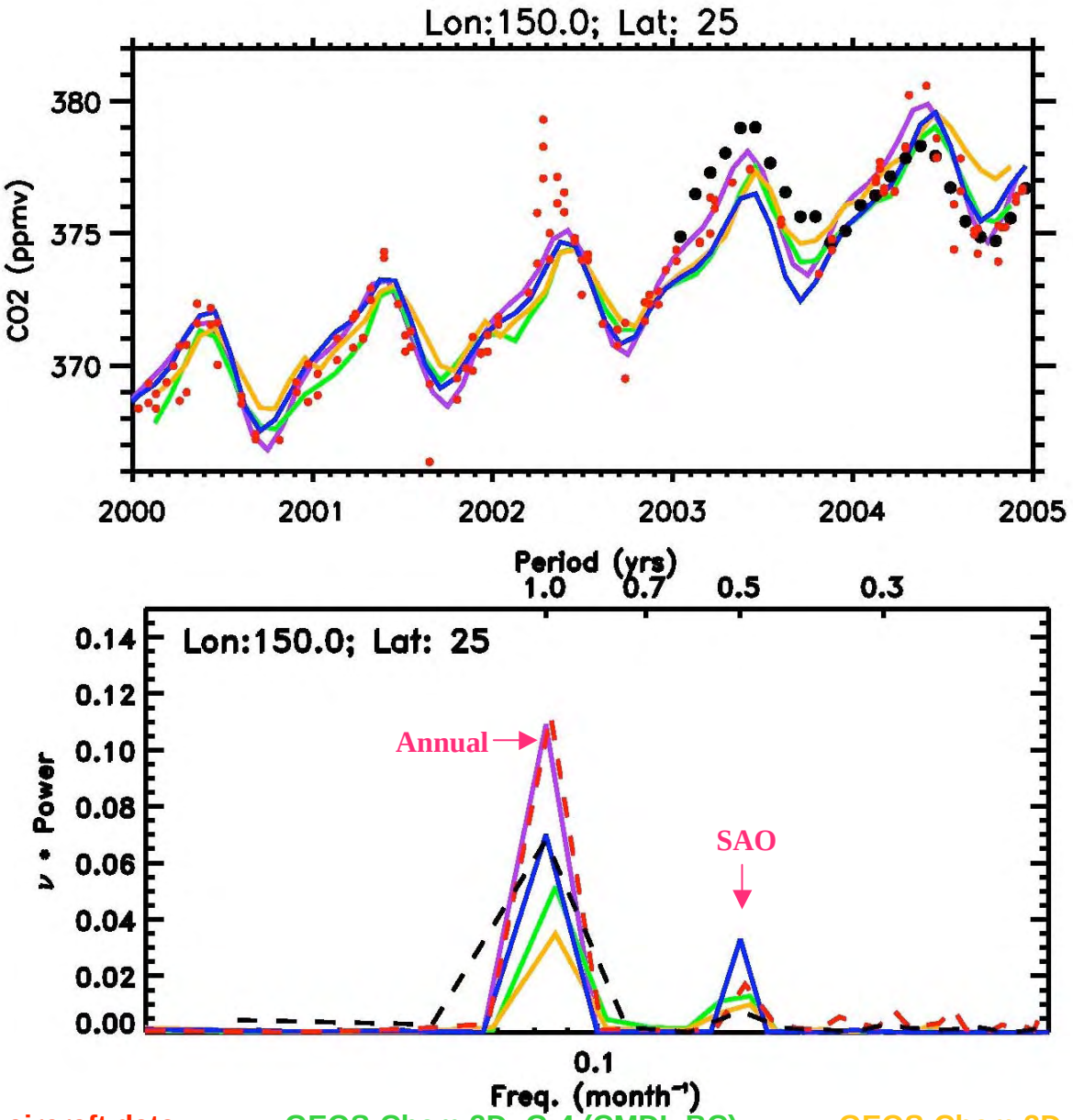
Semi-Annual Oscillation in AIRS CO_2



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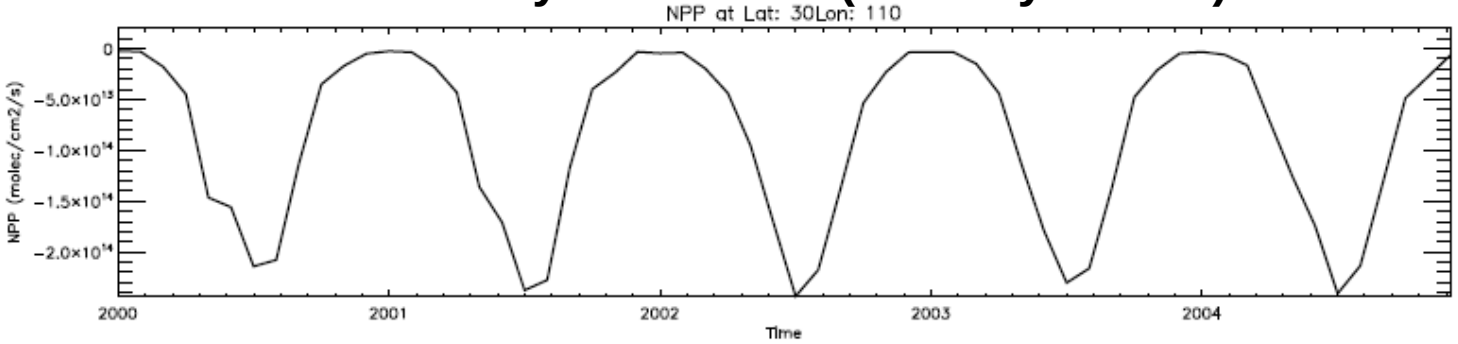
—— CJCTM 2D (CMDL BC) —— MOZART2 (CMDL BC)

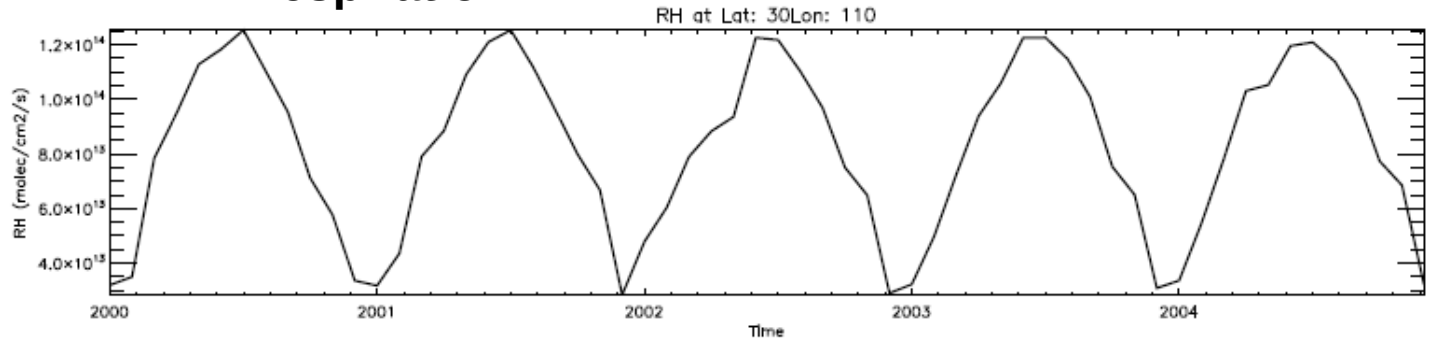
● Version 5 AIRS CO_2

Source for Semi-Annual Oscillation

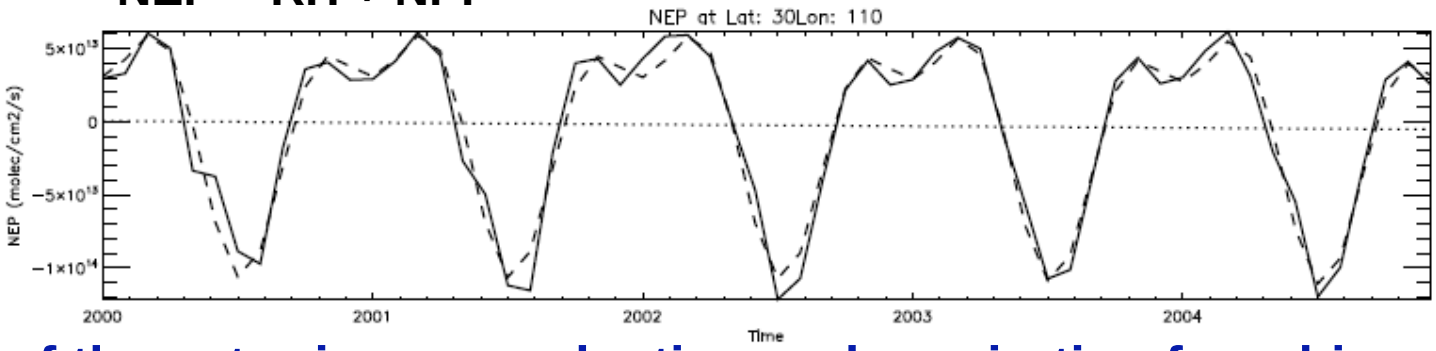
NPP = Net Primary Production (Photosynthesis)



RH = Respiration



NEP = RH + NPP



Sum of the net primary production and respiration from biosphere lead to the Semi-Annual Oscillation in CO_2

Conclusions

- With AIRS, we monitor the distribution and transport of global CO_2 on a weekly basis for the first time.

- The latitudinal distribution of AIRS retrievals of upper tropospheric CO_2 agrees reasonably well with in situ aircraft observations of CO_2 and model simulations.

- AIRS retrieved upper tropospheric CO_2 increases while AIRS 300 mb O_3 decreases following a sudden stratospheric warming event.

- Semi-annual Oscillation is found in the upper tropospheric CO_2.

Thank you!